

Journal Information

Journal ID (publisher-id): jgi

ISSN: 1910-7595

Publisher: Centre for Addiction and Mental Health

Article Information

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Received Day: 29 Month: May Year: 2006

Accepted Day: 23 Month: January Year: 2007

Publication date: June 2007

First Page: 193 Last Page: 213

Publisher Id: jgi.2007.20.6

DOI: 10.4309/jgi.2007.20.6

Mapping the prevalence of problem gambling and its association with treatment accessibility and proximity to gambling venues

Brian Rush¹²³Scott Veldhuizen¹Edward Adlaf³⁴

Health Systems Research and Consulting Unit, Centre for Addiction and Mental Health, Toronto, Canada. E-mail: brian_rush@camh.net

Department of Psychiatry, University of Toronto, Toronto, Canada

Department of Public Health Sciences, University of Toronto, Toronto, Canada

Public Health and Regulatory Policy, Centre for Addiction and Mental Health, Toronto, Canada

For correspondence: Brian Rush, PhD, Health Systems Research and Consulting Unit, T304, 33 Russell Street, Toronto, Ontario, Canada, M5S 2S1. Phone: 416-535-8501 ext. 6625, fax: 416-979-4703, e-mail: brian_rush@camh.net, URL: <http://www.camh.net/hsrcu/>

Contributors: BR conceived the study, BR and EA contributed to the study design, and SV conducted the data cleaning, analysis, and prepared a first draft. All authors were involved in writing the final draft of the paper.

Competing interests: None declared.

Ethics approval: The Centre for Addiction and Mental Health Research Ethics Board approved on March 19, 2003, the research project, "Assessing the geo-spatial association in Ontario between the prevalence of problem gambling, treatment availability and help seeking" (Protocol Reference #58/2003).

Funding: This study was supported by a grant from the Ontario Problem Gambling Research Centre.

Brian Rush (PhD, epidemiology and biostatistics, University of Western Ontario, 1987) is a senior scientist with the Centre for Addiction and Mental Health and is currently the associate director of the Health Systems

Research and Consulting Unit within the Centre and an associate professor in the Departments of Psychiatry and Public Health Sciences at the University of Toronto. He has worked for over 25 years in a research and evaluation capacity in the addiction and mental health fields. His research interests have included performance measurement for substance abuse, problem gambling, and mental health services, and prevalence and impact of concurrent substance and mental disorders. His gambling-related research has included an assessment of trends over time among those seeking treatment for problem gambling in Ontario as well as geographic mapping of the relationship between the prevalence of problem gambling in the community, the availability of help, and treatment service utilization. E-mail: brian_rush@camh.net

Scott Veldhuizen is a research analyst with the Health Systems Research and Consulting Unit at the Centre for Addiction and Mental Health (CAMH) and a graduate of the University of Toronto. His work at CAMH has included research on geographic variations in the prevalence of psychiatric disorders, psychometrics, psychiatric and substance abuse comorbidity, and the epidemiology of mental illness among older adults. Before joining CAMH, he worked for several years as a computer programmer and database analyst. E-mail: Scott_Veldhuizen@camh.net

Edward Adlaf, PhD, is a research scientist and co-head of the Public Health and Regulatory Policy Unit at the Centre for Addiction and Mental Health. Ed holds an appointment as associate professor in the Departments of Public Health Sciences and Psychiatry, Faculty of Medicine, University of Toronto, where he teaches survey methods. He has published widely in the area of alcohol and other drug use, including epidemiology, advanced statistical techniques, and methodological investigations, and he currently serves as an assistant editor for the journal *Addiction*. He has also served as a consultant to international organizations such as the Pan American Health Organization, the World Health Organization, and the United Nations, and the governments of Canada, Bahamas, Mexico, and the Cayman Islands, and he is currently coordinating a Global Audit of Student Drug Use for the United Nations Office on Drugs and Crime. E-mail: edward_adlaf@camh.net

Abstract

This study examined geographic variation in the prevalence of problem gambling in Ontario and the association with various demographic factors and proximity to treatment for problem gambling and gambling venues. Drawing upon multiple sources, secondary data analysis was undertaken based on multivariate statistical methods and techniques of geographic information systems (GIS).

Regional variation in prevalence of problem gambling was found in the province. Prevalence of problem gambling was associated with many demographic characteristics, as well as mental disorders, co-occurring substance abuse

problems, and physical health status. Geographic access to treatment was not associated with the risk of being a problem gambler. However, proximity to gambling venues was marginally important in predicting risk of problem gambling. Results are interpreted in the context of needs-based planning of treatment and prevention programs for problem gambling.

Introduction

Spatial variation in the prevalence and incidence of disease can quantify risks presented by hazards, inform decisions about the allocation of treatment resources, and help identify previously unknown risk factors. Interest in this area has been increasing recently, and methods of spatial analysis are now widely used in epidemiological research. Geographic information systems (GIS), used principally as visualization tools, are also increasingly popular in public health research. Both spatial analysis and GIS have been effectively applied in many areas of health care, including psychiatry (e.g., [Chaix, Merlo, Subramanian, Lynch, & Chauvin, 2001](#)) and substance abuse ([Latkin, Glass, & Duncan, 1998](#); [Midford et al., 1998](#)). Despite its emergence as a significant public health concern ([Korn, 2001](#)), problem gambling has seen fewer applications of these methods. Geographic variation in prevalence has, however, been reported in the United States ([Volberg, 1994](#)), in Quebec ([Kairouz, Nadeau, & Lo Siou, 2005](#)), and between Canadian provinces ([Cox, Yu, Afifi, & Ladouceur, 2005](#)). The links between gambling availability and local area characteristics, such as socioeconomic status, have also been explored ([Gilliland & Ross, 2005](#)).

Spatial variation of problem gambling in Ontario is of some special interest because the establishment of major gambling venues in the province constitutes something of a natural experiment. Spatial associations between availability and public health have been studied in the context of alcohol (e.g., [Zhu, Gorman, & Horel, 2004](#)) and fast food (e.g., [Reidpath, Burns, Garrard, Mahoney, & Townsend, 2002](#)), but these studies are limited by the difficulty of establishing precedence. It is not clear, for example, whether a high density of bars and liquor stores precedes a high prevalence of alcohol abuse; it is at least equally likely that their presence is simply a response to high local demand. Casinos, however, did not exist in the province before 1994, and their sites were not chosen principally to meet anticipated local demand. Similarly, funding of treatment services for problem gamblers has not followed a formal, needs-based funding formula ([Rush, Shaw Moxam & Urbanoski, 2002](#)).

A substantial body of Canadian research now exists on the occurrence, course, and treatment of problem gambling. A published review of studies conducted in eight provinces reported that between 2.7% and 5.4% of Canadian adults were problem or pathological gamblers in 1996 (National Council of Welfare [NCW],

1996). Several surveys of Ontario residents have also been conducted. In 1993, 7.7% of Ontario respondents scored between 1 and 4 on the South Oaks Gambling Screen (SOGS; [Lesieur & Blume, 1987](#)), indicating the presence of gambling problems, and an additional 0.9% scored 5 or higher, indicating probable pathological gambling ([Ferris, Wynne, & Single, 1998](#)). In 2000, 2.6% of a representative sample of Ontario adults scored 2 or greater on the SOGS ([Adlaf & Ialomiteanu, 2000](#)). These results have important limitations, however. The use of the SOGS in community-based studies has met with some criticism, owing in part to the lack of validation work with the general population (NCW, 1996; [Ladouceur, 1996](#)). Since 1994, the availability of gambling venues in Ontario has also changed rapidly, and the possible effects of these changes on the prevalence and distribution of problem gambling make it important to use the most recent available data. More recently, a 2001 Ontario population survey using the Canadian Problem Gambling Index (CPGI) reported a prevalence of 3.1% for moderate and 0.7% for severe gambling problems ([Wiebe, Single, and Falkowski-Ham, 2001](#)). A follow-up survey conducted in 2005 found prevalences of 2.6% and 0.8%, respectively ([Wiebe, Mun, & Kauffman, 2006](#)).

In 2002, Statistics Canada conducted cycle 1.2 of the Canadian Community Health Survey (CCHS 1.2), a large ($n = 36,984$) representative community survey of Canadians aged 15 and older focused on mental health and well-being. CCHS 1.2 included a detailed inventory of gambling behaviour and an assessment for problem gambling ([Statistics Canada, 2003a; 2003b](#)). These data have made it possible to examine problem gambling at the population level—its prevalence, risk factors, and distribution across demographic and socioeconomic groups, as well as geographic variation. In this study, we examined geographic differences across Ontario in rates of problem gambling, measured the extent to which these differences are explained by known risk factors (e.g., age, gender, comorbidity with mental and substance use disorders), and tested the independent effects of two potential environmental risk factors: exposure to gambling opportunities and accessibility of treatment. Although our study design will not permit a causal interpretation, increased exposure to gambling opportunities would be expected to be associated with higher prevalence rates. Research on alcohol use and abuse, for example, has been able to show at the population level that as the number of people in treatment increases there is a net decline in indicators of alcohol-related harms such as liver cirrhosis and suicide ([Mann et al., 2005](#); Mann et al., in press). Thus, we also predicted increased proximity to treatment venues to be associated with lower prevalence rates, as a result of positive treatment impact.

Methods

Four sources of Ontario data were used in the project: (a) population survey data from CCHS 1.2; (b) problem gambling treatment centre locations and capacities,

as measured by a survey of treatment programs undertaken as part of the present study; (c) locations and capacities of casinos and racetrack facilities with slot machines; and (d) spatial datasets.

a) Population survey data on the prevalence of problem gambling

CCHS 1.2 was a nationally representative community mental health survey conducted by Statistics Canada between May and December of 2002. The survey questionnaire included the CPGI, a measure of problem gambling appropriate for use with the general population ([Ferris & Wynne, 2001](#)). The survey was targeted at the Canadian population aged 15 years or older living in private dwellings, excluding full-time members of the Armed Forces as well as individuals living in health care institutions, on First Nations (aboriginal) reserves or government-owned land, in one of the three northern territories, or in other remote regions. This sampling frame included 98% of the Canadian population. The overall response rate for the survey was 77%, and the final sample size was 36,984. The Ontario subsample used here numbers 13,184. Further details on the design and methodology of the survey have been reported by [Gravel and Beland \(2005\)](#).

An important characteristic of the assessment of problem gambling in CCHS 1.2 is that respondents were screened out of the problem gambling section if they did not gamble with a certain frequency. Modules for mood and anxiety disorders also used short screens to avoid unnecessary interviews, but in these cases the screening items corresponded to core symptoms of the disorder in question. In the gambling module, however, individuals were screened out if they had not gambled more than five times in the previous year, or if they volunteered that they were “not a gambler” in response to the first question of the CPGI. Current clinical definitions of problem gambling, like those of substance use disorders, do not include a minimum frequency requirement, and individuals who identify themselves as current nongamblers may still have experienced problems in the previous year or with activities that may not be popularly considered “gambling” (e.g., high-risk investments). Although it is reasonable to expect that the majority of the excluded respondents would not have met criteria for problem gambling, the impact of this filtering process is unknown.

Our analysis defines problem gambling as a CPGI score of 3 or more. According to the instrument's scoring guidelines, this includes moderate-risk gamblers (CPGI score between 3 and 7) and problem gamblers (CPGI score between 8 and 27). Mood and anxiety disorders were identified using the World Mental Health version of the Composite International Diagnostic Instrument (WMH-CIDI), a widely used instrument in community surveys ([Kessler & Üstün, 2004](#)). Substance use problems are identified here by the presence of one or more abuse or dependence criteria according to *Diagnostic and statistical manual of mental disorders* (4th ed.) ([American Psychiatric Association, 1994](#)) within the previous 12 months.

CCHS 1.2 was designed to be representative at the provincial level. Ontario's contract for extra representation in the survey included adequate sampling procedures and sample size to be representative at the level of public health regions. Representativeness is not guaranteed at smaller scales, however, and so caution must be used in the interpretation of other geographic differences.

b) Problem gambling treatment capacity

A survey was conducted of managers of Ontario's outpatient problem gambling treatment programs to determine treatment capacity. A list of problem gambling programs was obtained from the Drug and Alcohol Registry of Treatment for this purpose and was cross-validated with a list of programs reporting to the Drug and Alcohol Information System (DATIS). Data were collected by telephone interview or e-mail correspondence. Of 48 programs targeted for the survey, we obtained data from 45 programs, for a response rate at the program level of 94%. This reflects data capture for the main site of the program, since our survey showed some missing data for a small number of low-caseload satellite offices. For analytical purposes, we measured treatment capacity of treatment centres as the estimated number of clients who could be treated in a given month and treatment accessibility as the estimated waiting time to assessment.

c) Location of casinos and racetracks with slots

The analysis included 28 gambling venues representing all commercial casinos (6), charity casinos (7), and racetracks with slot machines (15) located within the province or nearby in neighbouring provinces. Locations, opening dates, capacities, and other details were obtained from the Ontario Lottery and Gaming Corporation, occasionally supplemented from other sources where necessary.

d) Spatial datasets

Spatial data were obtained principally from the University of Toronto data library, which maintains a repository of GIS datasets. A postal code conversion file, which contains latitude and longitude coordinates for the centre point of all Canadian postal codes, was used to assign geographic locations to survey respondents. Files containing basic “background” geographic data, such as provincial and health region boundaries, were also obtained and used in the mapping process.

Measuring exposure and accessibility

In order to test possible effects of “exposure” to gambling venues and accessibility of gambling treatment, it was necessary to quantify both of these as proximity measures.

In the case of gambling, we concentrated on major gambling venues: commercial

casinos, charity casinos, and slots facilities at racetracks. These represent all legal and permanent facilities in the province offering slot machines and card gambling. These are the gambling habits cited as a primary problem by the majority of problem gamblers in treatment ([Urbanoski & Rush, 2006](#)) and by callers to the Ontario Problem Gambling Helpline. Locations of gambling venues and treatment centres are mapped in [Figure 1](#). Other common gambling activities, such as lottery tickets and bingo, were not considered because these are almost universally available, are more rarely cited as problem activities by gamblers, are more strongly responsive to local demand (making their inclusion as independent “risk factors” dubious), and are extremely difficult to collect adequate data on. Gambling venues in Hull, Quebec, and Winnipeg, Manitoba, were included, but those in the United States were not. This decision was based on evidence from the DATIS client database, which indicated that gambling in other provinces was relatively common among problem gamblers in treatment in eastern and northwestern Ontario, while gambling in other countries was comparatively rare.

In order to quantify exposure to gambling, several variables were entered into logistic regression models and combined into an index. These measures were

- the natural logarithm of the linear distance from each respondent to the nearest commercial casino, to the nearest charity casino, and to the nearest slots facility, where each was 200 km or less;
- dummy variables indicating distances greater than 200 km for each venue type;
- the number of days the nearest venue of each type had been open (important because most large gambling venues in Ontario were relatively new at the time of the CCHS 1.2 survey).

Initially, both the linear distance and its transformation were included in the first measure, but the latter proved as good a predictor as both together.

Only gambling venues open for 90 days or longer as of the respondent's survey date were included. This was an important consideration in the case of the Thousand Islands Charity Casino, which opened during the survey period, and the Georgian Downs racetrack, which opened a slots facility late in 2001.

Our use of a combined proximity index was adopted as a compromise between flexibility and the need to keep the number of statistical tests reasonable. A more complete method would allow the exposure relationship itself to vary geographically (since distance, for example, can be expected to be less of a deterrent in more remote areas), but the limited sample size means that the number of tests involved would quickly become problematic.

Treatment accessibility was similarly measured by

- the distance to the nearest treatment centre,
- the capacity of that centre,
- the estimated waiting time for assessment of problem gambling at that centre.

Treatment accessibility measures were calculated for each respondent by identifying the nearest available treatment centre without demographic or other restrictions that would have excluded him or her. This meant, for example, that centres offering treatment for women only were not considered for male respondents.

Six-digit postal codes were used to assign latitude/longitude locations to respondents, making it possible to treat individuals as “point” data. An external geocoding service was used to obtain more precise locations for treatment facilities and gambling venues, for which addresses were known. Linear distance was used because respondent locations were not known exactly and available road and rail network data were inadequate; attempts to estimate travel barriers in more detail would, therefore, not have produced acceptable results. Other geographic identifiers supplied with the CCHS 1.2 data made it possible to group respondents by census metropolitan area (CMA) and health region. CCHS 1.2 used a complex survey design. In order to obtain accurate standard errors and significance tests, all models and bivariate tests were bootstrapped using a set of replicate weights supplied by Statistics Canada. The WesVar 4.2 software package was used for this purpose.

Cluster scans were performed with SaTScan 3.0, using survey weights rescaled to a mean of one and divided by the overall survey design effect, which was 2.3. Mapping and interpolation was done with ArcGIS 8.3 and 9.0.

Analysis

Describing the geography of problem gambling in Ontario

We used three approaches to characterize spatial patterns of problem gambling in the province. First, we calculated estimates and confidence intervals for those existing regions that were both large enough to support stable estimates and of some independent interest: CMAs and provincial health regions.

In addition to conventional tests of regional variation, we also performed a spatial cluster scan for areas of high and low prevalence. The software used, SaTScan 3.0.5 ([Kulldorf & Information Management Services, Inc., 2002](#)), considers the counts of cases and noncases in all possible clusters (circles of varying sizes including one or more data points) within a region and reports the most likely along with an estimate of relative risk and statistical significance. Details on this process

are available in [Kulldorff \(1997\)](#). Full cluster scan results cannot be displayed because of disclosure issues raised by Statistics Canada, but they functioned as a valuable check on the general regional patterns observed.

Testing gambling availability and treatment accessibility as predictors of problem gambling

Variables previously shown to be associated with problem gambling and other important control variables were tested against problem gambling “caseness” in a series of bivariate tests. Health regions and CMAs were also tested in this way.

Along with proximity measures, these variables were then entered into a series of logistic regressions predicting caseness for problem gambling. Significance for proximity variables was assessed as the difference in overall model fit, with and without the exposure and “accessibility” variables, respectively. The inclusion of multiple indicators of a single source of risk has the effect of reducing this significance level; this penalty reflects the risk of overfitting. Another limitation of this approach is that it is difficult to represent the relationship between exposure and risk when the former is defined by several different variables. In this analysis, the possibility of reporting a dose-response relationship has been sacrificed in favour of a broader test to establish the presence or absence of a relationship.

Results

A total of 244 probable problem gamblers were identified in the CCHS 1.2 sample from Ontario. After taking survey design into account, prevalence in the province was 2.0% (95% CI = 1.6% to 2.4%), a rate identical to the national estimate. Prevalence varied significantly by health region ([Figure 2](#)), with that in the Ontario East region, at 0.9%, significantly lower than in the rest of the province. Statistically significant clusters of low and high prevalence were identified in the East and in the Central West regions, with a large low-risk area covering most of the eastern region and two smaller high-risk areas in the western part of the Greater Toronto Area (GTA). Low prevalence rates were observed for London and Ottawa ([Figure 3](#); both 0.9%). Rates were higher in several regions and CMAs, but 95% confidence intervals for these areas substantially overlap those obtained for the province as a whole.

Among demographic and other predictor variables, problem gambling was significantly, and independently, associated with male gender, current employment, low education, being formerly married, having poor self-described health, and having a substance use disorder (abuse or dependence) in the previous 12 months ([Table 1](#)). The age variables (age and age squared) indicated a nonlinear relationship, with increasing risk up to age 35 and then declining thereafter. Odds ratios were above one for ages between 25 and 45. Variables indicating the

presence of mood and anxiety disorders became nonsignificant in the presence of the substance problem variable, with the odds ratio for anxiety disorders, in particular, moving very close to one.

No effect on risk was observed for treatment accessibility ([Table 2](#)). However, the variables chosen to capture exposure to gambling venues had a modest, but significant, positive association with being a problem gambler.

Discussion

At 2%, our estimate of the prevalence of problem gambling in Ontario is somewhat lower than rates reported in earlier and even contemporaneous studies. This may be due to differences in the instruments and cutoffs used, and perhaps also to low response rates in some surveys. As researchers have acknowledged (e.g., [Wiebe et al., 2006](#)), nonresponse bias is a considerable problem in gambling research: Respondents who do not gamble may be disinclined to participate in dedicated surveys, which they may perceive as irrelevant or uninteresting. This may be less important in the case of CCHS 1.2, in which assessment of problem gambling was a small part of a much larger questionnaire. While not without its limitations, CCHS 1.2 was also carefully designed to be representative and combined a large sample size, a well-validated instrument, and a reasonably good response rate. The estimate it provides is, therefore, likely to be the best currently obtainable.

There are substantial regional variations in the prevalence of problem gambling in Ontario that have not been identified previously. The most robust finding is the low prevalence in eastern Ontario. This is supported by all measures and methods of analysis used, with results including a large cluster of low rates covering much of the region and comparatively low prevalences for the Ottawa CMA and the Ontario East health region, the latter remaining significant after adjustment for known risk factors. Somewhat above-average rates were noted in several areas, but these fell short of statistical significance.

The elevated rate for the Central West health region deserves further attention, however. Small clusters of high rates were detected in the western suburbs of the GTA, and individual CMAs partly within the region (Toronto, Hamilton, and Kitchener) all had rates above the provincial average.

While it is not possible to fully explain the observed regional differences in prevalence, problem gambling appears to be modestly but significantly associated with proximity to casinos and racetracks with slot facilities. As we have noted, this relationship is difficult to interpret with confidence; it is possible, for example, that geographic differences in unmeasured variables may have confounded the association. Nevertheless, treatment data, as we have noted, indicate that casino

games are the most common primary problem of people in treatment, and it is not difficult to accept that easy access to these forms of gambling might constitute an independent risk factor for problem gambling. Future research might provide more substantial evidence on this question by making careful use of multiple community surveys to detect emerging differences between areas with and without easy access to casino gambling.

In existing research, the most consistently observed demographic correlates of problem gambling in the general population have been male gender, living outside a married/common-law relationship, and lower education ([National Research Council, 1999](#)). Our findings are consistent with earlier reports in these areas. Whereas younger age is usually associated with a higher risk of problem gambling ([National Research Council, 1999](#)), some studies have reported higher risk in the middle age categories ([Smart & Ferris, 1996](#); [Petry, Stinson, & Grant, 2005](#)). We found a nonlinear relationship with age (peaking at age 35) and submit that the association between problem gambling and age is more complex than a comparison of younger versus older clients can fully assess. Comparisons across studies are complicated, however, by differences in measures and possibly by cohort effects.

Previously reported findings have been inconsistent with respect to employment status and problem gambling, with many studies finding no association ([National Research Council, 1999](#)), and others finding the unemployed to be more likely to be problem gamblers ([Abbott & Volberg, 1996](#)). Our findings showed problem gambling to be associated with being employed. The significance level of this association is, however, marginal ($p = 0.04$) and, given the number of other control variables included, would not survive a correction for multiple tests.

Co-occurring substance abuse is an important correlate of problem gambling in the present sample, a finding consistent with previous work in both community and clinical samples ([Shaffer & Korn, 2002](#); [Volberg, 1994](#); [Cunningham-Williams, Cottler, Compton, & Spitznagel, 1998](#); [Shaffer, Freed, & Healea, 2002](#); [Smart & Ferris, 1996](#); [Spunt, Dupont, Lesieur, Liberty, & Hunt, 1998](#)). Like many other studies, we also found a strong bivariate relationship between problem gambling and co-occurring mood and anxiety disorders ([Shaffer & Korn, 2002](#); [Cunningham-Williams et al., 1998](#)). Interestingly, however, this relationship was nonsignificant when substance abuse was included in the analysis. While neither causality nor precedence can be reliably determined with cross-sectional data, it remains interesting that problem gambling was more closely associated with substance abuse than with co-occurring mood and anxiety disorders.

The relationship between problem gambling and poor self-reported physical health status has been reported in other studies, with samples drawn from methadone maintenance clinics ([Weinstock, Blanco, & Petry, 2006](#)) and a nonrandom

community sample of older adults ([Erickson, Molina, Ladd, Pietrzak, & Petry, 2005](#)). In a general population sample, [Wiebe et al. \(2001\)](#) reported that those with moderate and severe gambling problems were more likely to report being under a doctor's care for emotional or physical problems brought on by stress. The results of the present study showing the link between poorer health status and problem gambling confirm these associations in a large representative community sample and go further by showing this association to be independent of co-occurring mental disorders or substance abuse. Explanations for this association focus on the role of stress as a mediating factor (e.g., [Potenza, Fiellin, Heninger, Rounsaville, & Mazure, 2002](#)), although a recent study by [Scherrer et al. \(2005\)](#) shows the important role of both genetic and family environment. Regardless of the underlying mechanisms, the results suggest the need for programs and professionals providing treatment for problem gamblers to assess physical health status and incorporate the results into treatment plans. The findings also suggest the need for proactive screening for problem gambling in primary care and other health care settings. Further research is also needed on the burden of illness and health care costs associated with problem gambling in order to better assess consequences of problem gambling from a population health perspective.

As noted, we have identified considerable variation in the prevalence of problem gambling across Ontario. Given our reliance on secondary data analysis, we are limited in our capacity to tease apart what is undoubtedly a host of individual and community level factors underlying this intraprovincial variation. Our data do, however, provide modest evidence that some of the variation is associated with availability of gambling venues.

Thus, the data lend modest support to policy options intended to reduce harms associated with gambling by controlling the expansion of legalized gambling venues such as casinos and racetracks with slot machines. Our findings are also consistent with the gaming profile of clients entering treatment for problem gambling, namely an increase in the proportion of treated cases for whom slot machine play is the primary problem during a period of rapid increase in community access to legalized slots ([Urbanoski & Rush, 2006](#)).

We did not confirm a relationship between the availability of treatment for problem gambling and rates of problem gambling in the community. One might have expected closer proximity to treatment to attenuate community prevalence by facilitating recovery from problem gambling. Other research with respect to alcohol use/abuse has been able to show associations at the population level between the number of people in treatment and indicators of alcohol-related harms such as liver cirrhosis and suicide ([Mann et al., 2005](#); Mann et al., in press). The lack of association between the availability of treatment for problem gambling and community prevalence rates may result from the low level of treatment seeking

—estimated at 1% to 2% per year ([Rush, Shaw Moxam, & Urbanoski, 2002](#))—of people meeting criteria for gambling problems. This does not make an effect on prevalence inconceivable, however; treatment centres also raise awareness of the problem, and effective treatment might still have an observable effect over time. Also working against the probability of finding an association, however, is the fact that the capacity and location of treatment are to some extent responsive to levels of local need. As we have noted, although establishment or funding of treatment facilities in Ontario is not tied formally to a quantitative assessment of local need, it is not unlikely that capacity exists where need is greatest. So we may not have found an association with treatment proximity since prevalence may have been substantively higher in those areas from the outset. Finally, it is possible that treatment provides a public health benefit, even in the absence of a discernable effect on overall prevalence, by successfully treating or ameliorating the most severe problems.

Overall, our findings are important for discussion of intraprovincial needs-based allocation of prevention and treatment resources for problem gambling. In this context, the strong association between problem gambling and substance abuse also confirms the importance of addressing prevention and treatment of problem gambling in the context of addictive behaviour and disorders generally. Our use of GIS technology contributed uniquely to our understanding of regional variations in prevalence by enhancing our ability to efficiently organize our data along spatial dimensions, to efficiently and rapidly visualize relationships in several ways, and to interpolate data across regions. Expanding the data set to incorporate a variety of other population level indicators associated with substance use and harms may provide additional insights. The recent reorganization of health services into Local Integrated Health Networks also provides a new policy-relevant, geographic structure for organizing and interpreting such data for decision-makers.

Limitations

In addition to the difficulties in quantifying exposure to gambling opportunities already mentioned, our findings are constrained in other ways. While CCHS 1.2 provided a large sample, the relatively low prevalence of problem gambling means that only 244 problem gamblers were identified. This affects the precision of the regional survey estimates and our ability to identify statistically significant differences. Our methods also did not include detailed consideration of neighbourhood-level factors such as local employment rates, neighbourhood density, and other indicators of community wellness. Other potentially important missing variables are markers of culture such as ethnicity and language. These could not be included because of data limitations or sample size issues.

Future research

A number of more sophisticated approaches to the modelling of the spatial relationships might be applied if their data requirements could be met. The attractive power of individual gambling or treatment facilities, or of the cities in which they are located, might usefully be modelled. With a larger sample, it might also become reasonable to attempt to include known patterns of travel, such as commuting for work, recreation, or shopping. More precise information on respondent locations might also make it possible to use detailed information on road and rail networks to construct measures of accessibility that would be more meaningful than simple proximity.

Another technique of spatial analysis that might usefully be brought to bear is spatially weighted regression, which might be used to examine variations in the effect of risk factors across areas. One candidate for such an analysis is proximity itself. For example, distance may be a weaker deterrent to individuals in remote areas who are accustomed to regularly travelling long distances. Other techniques of cluster scanning might also prove useful, including “hazard” methods and space/time scans, which take the timing of cases into account.

Finally, if the availability of casino gambling does affect the prevalence of problem gambling, differences should be observed at the population level and over time. If future large and well-designed national health surveys continue to assess respondents for problem gambling, it will be possible to obtain more robust estimates and to track changes in prevalence and availability over time. Such a series of cross-sectional surveys might provide a robust opportunity to study the impact of changes in both treatment and gambling availability.

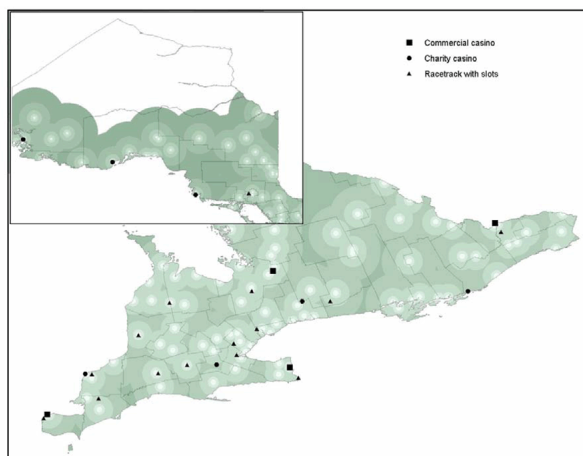
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Figures



¹ Buffers are shown around gambling treatment centres.

² Inset map shows the northern part of the province

Figure 1.

Location of major gambling venues and treatment centre accessibility¹ in 2002²

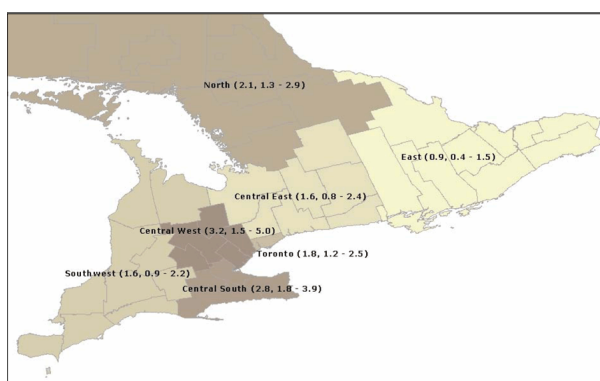


Figure 2.

Prevalence of problem gambling by public health unit (%; 95% CI)

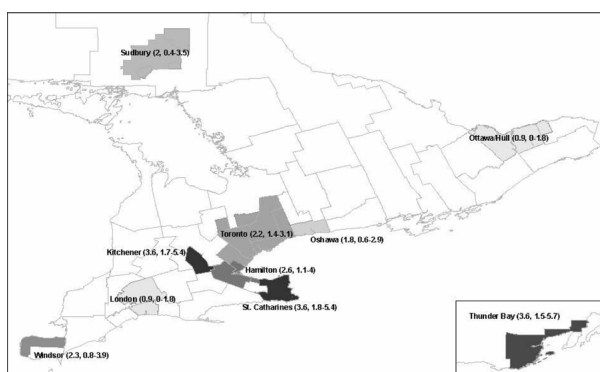


Figure 3.

Prevalence of problem gambling for major CMAs (% , 95% CI).

Tables

Table 1

Results for base logistic regression model predicting problem gambling and for model with regions added (odds ratios and 95% CIs)

Variable	Base model	Region variables
Constant	0.01	0.01
Female	0.53 (0.35–0.8)**	0.52 (0.35–0.8)**
Male	(ref.)	(ref.)
Age	1.06 (0.99–1.13)	1.05 (0.99–1.12)
Age squared	0.999 (0.999–0.999)	0.999 (0.999–0.999)
Employed	1.81 (1.03–3.16)*	1.77 (1.0–3.14)*
Not employed	(ref.)	(ref.)
Low income adequacy	0.58 (0.3–1.14)	0.61 (0.31–1.18)
Education: < Secondary	2.07 (1.3–3.3)**	2.09 (1.3–3.32)**
Education: Completed secondary	1.68 (1.08–2.61)*	1.68 (1.07–2.63)*
Education: Some postsecondary	0.77 (0.36–1.66)	0.81 (0.38–1.75)
Education: Postsecondary degree	(ref.)	(ref.)
Rural	0.88 (0.27–2.89)	0.98 (0.29–3.27)
Urban	(ref.)	(ref.)
Marital status: Single	1.25 (0.74–2.11)	1.23 (0.72–2.08)
Marital status: Married	(ref.)	(ref.)
Marital status: Formerly married	2.34 (1.34–4.08)**	2.3 (1.32–3.99)**
Immigrant status	0.98 (0.61–1.57)	1.16 (0.68–1.97)
12-month substance use disorder	2.59 (1.53–4.36)**	2.51 (1.48–4.26)**
12-month mood disorder	1.44 (0.78–2.66)	1.38 (0.73–2.59)
12-month anxiety disorder	1.03 (0.54–1.94)	1.01 (0.53–1.92)
Health-description index	0.77 (0.61–0.97)*	0.77 (0.61–0.98)*
Central E Ontario		0.69 (0.31–1.54)
Central S Ontario		1.2 (0.62–2.32)
Central W Ontario		1.42 (0.71–2.84)
East Ontario		0.41 (0.18–0.93)*
N Ontario		0.83 (0.4–1.7)
SW Ontario		0.63 (0.3–1.31)
Toronto		(ref.)

** $p < 0.01$; * $p < 0.05$.

Table 2

Results for model predicting problem gambling with proximity measures added (odds ratios and 95% CIs)

Variable	Treatment accessibility	Proximity of gambling venues	Full model
Constant	0.01	2.13	0.8
Female	0.53 (0.35–0.8)**	0.52 (0.34–0.79)**	0.52 (0.34–0.79)**
Male	ref.	ref.	ref.
Age	1.05 (0.98–1.12)	1.05 (0.98–1.12)	1.05 (0.98–1.12)
Age squared	0.999 (0.999–0.999)	0.999 (0.999–0.999)	0.999 (0.999–0.999)
Employed	1.83 (1.04–3.2)*	1.83 (1.04–3.23)*	1.85 (1.05–3.26)*
Not employed	ref.	ref.	ref.
Low income adequacy	0.58 (0.29–1.13)	0.6 (0.31–1.18)	0.59 (0.3–1.16)
Education: < Secondary			
Education: Completed secondary	2.06 (1.3–3.28)**	2.05 (1.29–3.26)**	2.08 (1.3–3.31)**
Education: Some postsecondary	1.69 (1.08–2.64)*	1.69 (1.08–2.63)*	1.7 (1.08–2.67)*
Education: Postsecondary degree	0.78 (0.36–1.68)	0.79 (0.37–1.7)	0.8 (0.37–1.71)
Rural	1.13 (0.31–4.16)	1.03 (0.28–3.79)	1.19 (0.3–4.68)
Urban	ref.	ref.	ref.
Marital status: Single	1.2 (0.7–2.05)	1.19 (0.69–2.06)	1.18 (0.68–2.04)
Marital status: Married	ref.	ref.	ref.
Marital status: Formerly married	2.32 (1.32–4.06)**	2.32 (1.33–4.05)**	2.31 (1.32–4.04)**
Immigrant status	1 (0.63–1.6)	1.12 (0.69–1.82)	1.11 (0.68–1.81)
12-month substance use disorder	2.56 (1.52–4.32)**	2.53 (1.51–4.24)**	2.54 (1.52–4.26)**
12-month mood disorder	1.34 (0.71–2.51)	1.36 (0.72–2.56)	1.32 (0.7–2.51)
12-month anxiety disorder	0.97 (0.5–1.87)	0.96 (0.49–1.89)	0.95 (0.48–1.88)
Health-description index	0.76 (0.6–0.97)*	0.76 (0.6–0.97)*	0.76 (0.6–0.97)*
Treatment accessibility	ns	—	ns
Gambling venue proximity	—	*	*

** $p < 0.01$; * $p < 0.05$.

Keywords:

Keywords

gambling availability

,

geographic information systems

,

problem gambling prevalence

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